Gas Journal

VOL. 297. 111th YEAR. LONDON, JANUARY 14, 1959 No 4983 PRICE 1/6

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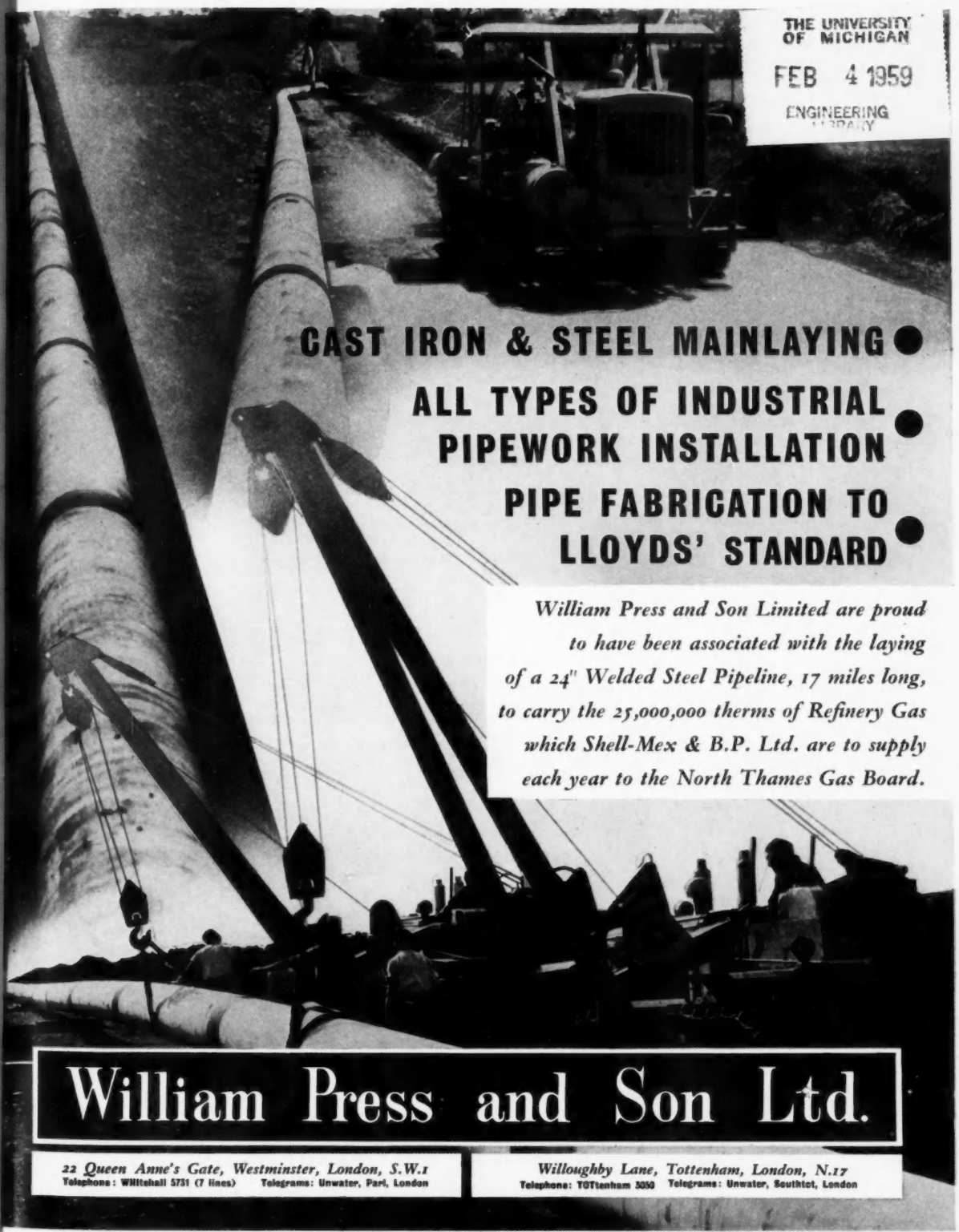
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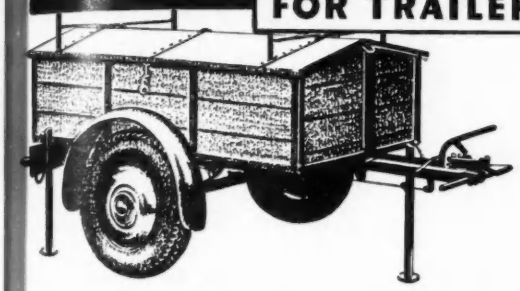

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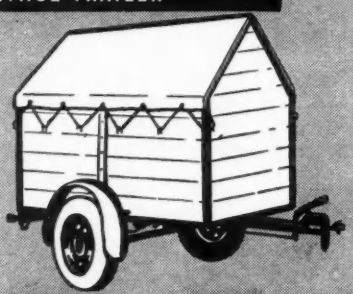

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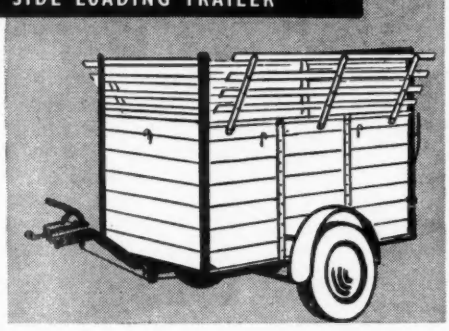

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Gas Journal

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111TH YEAR

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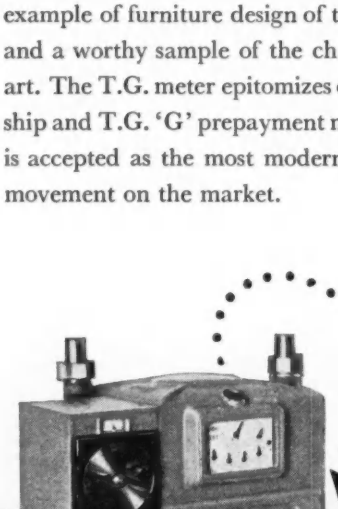
something in common

They remind one of different worlds, the antique chair of 1680-1700 and the modern T.G. meter. Yet they *have* something in common — both are the products of true craftsmanship. The chair, in the style popularly known as 'William and Mary', is attributed to Daniel Marot who designed much of the furniture for Hampton Court Palace. It is presented here as a fine example of furniture design of that period and a worthy sample of the chairmakers' art. The T.G. meter epitomizes craftsmanship and T.G. 'G' prepayment mechanism is accepted as the most modern precision movement on the market.



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Gas Journal

VOLUME 297. No. 4983 JANUARY 14, 1959. 111th YEAR

A Struggle for an Industry's Life

THE heavy stocks of coal accumulated at the pithead by the National Coal Board in 1958 have caused much rethinking about this country's fuel industries in the coming years. Gone, it seems, are the days when coal was at a premium and every ton raised was in demand. Gone, too, are the times when the employees of the coal mining industry were in a position to state their demands, knowing full well that they would be ignored only at the country's peril. The possibility also of a fuel famine, such as occurred in the early months of 1947, seems impossible of repetition. What has brought about this complete change in the fuel situation? Why, when we were importing as much as 200 mill. tons of coal as lately as two years ago, has the situation been reversed?

The answer, we think, lies in two directions. One of these, which is almost certainly temporary, is the slowing down of industry in 1958. The other, which is a sign of increasing mechanisation and therefore permanent, lies in the steps taken by successive Governments to encourage the use of oil burning by industry in place of coal for steam raising and other uses. Even as long ago as the 1947 fuel famine, the greater use of oil was being encouraged and many in the gas industry will remember the exhortations to use more oil by the greater production of carburetted water gas, and the subsidy then in being to reduce the cost of oil to the industry for this particular use. When the annual financial deficits of the N.C.B. caused by the import of large tonnages of coal from abroad became serious at one stage of the Board's existence, it was decided to overcome this by increasing oil imports. At the same time the oil companies were developing refineries in Great Britain to make possible the importing of crude oil on an ever increasing scale instead of refining it abroad and importing the products. This in turn has caused a great expansion in the petrochemical industry in Great Britain, from the products of which are obtained the raw materials for the manufacture of plastics, detergents, and so on. In fact a new industry of the utmost importance has been established in this country since the war.

The increasing cost of suitable coal to the gas industry and the difficulty in obtaining the exact quality for efficient gas and coke production have led the gas industry to devise new methods of gas making from the more conveniently handled oil. The result has been that year by year an item in the Gas Council's annual report records the fact that greater makes of gas have been possible with the consumption of less and less coal. The new processes now being developed by the industry will be capable not only of using the cheapest grades of coal, but in all probability the very minimum quantities.

What is the National Coal Board going to do to counter the increasing hardening in the demand for its products? It is clear that it is fully alive to the situation now developing and it is needless to stress that drastic measures are being taken to prevent further over-production in the coming year. The Board realises that coal must once more be made competitive in price with oil, and all possible steps must be taken to reduce production costs. Its aim, therefore, must be to produce cheaper coal and not more coal at any price. To make this possible the drive must be intensified towards developing new pits which can be worked more cheaply. There is no intention of reducing capital investment on such development between now and 1965. Old uneconomic pits will have to be closed down a little sooner than was first planned so as to reduce the output of coal generally. This entails hardship through local unemployment, and naturally the Board is only doing this as a last resort. It estimates, however, that the accelerated closing of pits now planned would this year involve about 12,000 men, about three-quarters of whom could be immediately re-employed at other collieries. But since the annual wastage of manpower is reckoned at

about 65,000, the remainder put out of employment should be easily absorbed if recruiting were stopped.

This general process has been going on for the last few years, and the latest statistical results published by the Board showed that planned mechanisation in the most up-to-date pits is having a marked effect on coal production. During 1958, 204 mill. tons of coal and 4¾ mill. tons of coke were sold at an average reduction of 3s. per ton in cost of coal production. Although it was clearly a difficult year, the loss incurred by the Board amounted to only £10 mill. on a turnover of £1,000 mill., and not the £30 mill. estimated at the beginning of the year. By keeping recruitment below the normal wastage of manpower at most collieries, a reduction of 22,000 men was made possible without causing serious redundancy. The output per man shift—the most effective way of measuring pit efficiency—taken over the whole industry, rose again in 1958 from 24.6 cwt. to 25.3 cwt., a rise of 3%, and a record. Its analysis throughout the coalfields is interesting, since it varies within such wide limits. It is at its lowest in the South Western Division, which includes the South Wales coalfield with its narrow seams (therefore mechanised with greater difficulty), and is at its highest in the East Midlands; the difference is 19.6 cwt.

This emphasises one of the difficulties to be faced by the Board in any scheme of cost reduction. Another is the higher wage bill of £10 mill. which will have to be paid in 1959, and a third is the demand for the shorter week for underground workers which, it is estimated, will cost the industry between £40 and £50 mill. a year.

The National Coal Board does indeed seem to be facing immense problems. For not only does the cost of getting the coal continue to rise because labour costs are such a high proportion of total costs, but also the total reduction in coal demand is clearly aggravated by the greater flexibility and far greater convenience in the use of refined fuels. To let the coal industry die a slow but certain death is both impossible and undesirable. Impossible because a great deal of coal is still used in Great Britain, and undesirable because the future estimates of the availability of other fuels makes it quite clear that in the years to come this country may be very glad of its coal measures.

To quote from an interview, given by Sir James Bowman, Chairman of the N.C.B., to reporters recently: 'We are facing a struggle for the life of coal in Great Britain.'

Pipelines—The Key to the Grid

THERE is little doubt concerning the increasing interest of the gas industry in pipelines, their construction and maintenance. This was further emphasised by the fact that Mr. A. D. L. Copp, Distributing Engineer of the North Thames Gas Board, should have recently addressed a meeting at Caxton Hall of the Pipeline Industries Guild, of which he is a founder member. He took as his subject the laying of the main to transport refinery gas from Shell Haven to the Board's reforming plant at Romford and illustrated his address with a film showing work in progress on the welding of the steel pipe sections, the use of mechanical excavators, and the use of special travelling cradles for 'snaking' the pipeline into its trench. Many of these techniques are being accepted almost as commonplace in the industry today and we have published papers dealing with such pipelines from time to time. Undoubtedly the first pipeline to be laid for a major link in a board's grid system, using all the latest mechanical aids, was the North Wales grid from Wrexham westwards. This particular project had the distinction of being surveyed by helicopter with a consequent saving in time and effort.

In the minds of the general public, the word pipeline is linked with the Middle East oil pipelines transporting oil from the wells to a suitable port in the Eastern Mediterranean for subsequent shipment to Europe or elsewhere. The big American networks for conveying natural gas from the south to the populous eastern seaboard are also well known. It is only lately, however, with the increase in the need for gas transmission in bulk, that large-scale pipe laying in this country has come to the forefront.

The earliest pipelines used by the gas industry were almost certainly the twin 48-in. mains laid between Beckton and the London of 90 years ago. These, being of large diameter, operated at holder pressure and were constructed of cast iron. Today they are still in use but the pressure has been raised to about 4 lb. per sq. in. to enable greater volumes to be carried. An early grid system employing a pipeline of moderate length was the Yorkshire gas grid, which made possible the picking up of coke oven gas at several points and making it available to consumers in the area. This had also been successfully carried out on a smaller scale in South Wales by the Rhymney and Aber Gas Company which took its gas from the Bargoed coke ovens and supplied it to all the villages in the two adjacent valleys.

Today there is an increasing tendency for gas boards to make use of all sources of gas production, including refinery gases and methane drained from coal mines. We cannot help thinking that if this is pushed to its logical conclusion, pipelines may well become more important than gasworks. Though the gas production plants will very likely be built in the coalfields, especially the Midlands coalfield, and the gas made transmitted mostly north and south, we think it is unlikely that the state of affairs obtaining in America and some Continental countries, by which separate authorities control the production, transmission and distribution of town gas, will ever be duplicated here. If a national grid is ever in fact laid, what body will be responsible for its construction and by what means will gas be purchased and sold from it to individual gas boards? Alternatively, will a national grid merely mean a joining up of existing grid systems, and will the exchange of gas from one area to another be by private arrangement between individual area boards? Whatever arrangement made, the design of all existing or future grids should fall easily into a future master plan for the supply of gas throughout the country as a whole. As yet we think it is too early to do more than say that to meet energy demands and industrial convenience refined fuels supplies must be maintained.

Personal Notes

MR. LESLIE F. STEMP, Legal Adviser to the Gas Council, is to retire after 33 years' service to the gas industry. Mr. Stemp joined the National Gas Council in 1926 as Legal Assistant to Colonel S. S. Ogilvie. Mr. Stemp was later appointed Legal Adviser to the National Gas Council, then to the British Gas Council: when the industry was nationalised he became the first Legal Adviser to the Gas Council. He was also Joint Honorary Secretary to the Conjoint Conference of Public Utility Associations. Mr. Stemp, a Member of the Order of the British Empire, holds the degrees of B.A. and LL.B. Called to the Bar in 1921, he became the pupil of Lord Jowett for whom he visited certain parts of Africa. Subsequently he practised in the Chambers of Lord Merriman. While practising at the Bar he published a book on *Public Speaking* which was followed by a new edition of *Michael and Will on the Law of Gas*, his co-editor being Mr. Harold Willis, Q.C. In addition, he wrote *Butterworth's Book on the Gas Act, 1948*. One of his most arduous tasks was writing the article on gas in *Halsbury's Laws of England*. During the first world war he served in the Royal Field Artillery and was a prisoner-of-war in Germany. He was demobilised with the rank of major.

MR. HEDLEY PARKER will succeed Mr. Stemp as Legal Adviser. He joined the Gas Council as an Assistant Secretary in December, 1953, and has been Assistant Legal Adviser since 1956. A former pupil at Gresham's School, Holt, Norfolk, and the Sorbonne his education was interrupted by the war. Returning from service with the Army, he completed his studies at Cambridge where he was awarded an Honours Degree in Law. In 1950 he was called to the Bar by the Middle Temple. During the next four years he was first a pupil of Mr. C. D. (now His Honour Judge) Aarvold, and after serving as Marshal to Mr. Justice Finnemore engaged in practice at the Bar in the Chambers of the late Sir Godfrey Russell Vick, Q.C.

MR. R. HUSSEY, who for several years was manager of the Power Plant Division of Elliott Bros. (London) Ltd., has taken up the position of Sales Director of James Gordon & Co. Ltd. The Power Plant Division of Elliott Bros. moved early in 1958 to the offices of James Gordon & Co. Ltd., Dalston Gardens, Stanmore. This division has now been amalgamated with James Gordon & Co., Ltd., so that Gordon can in future offer schemes for complete instrumentation and control (either pneumatic or electronic).

MR. ERIC NEWBIGGING becomes Sales Promotion Manager to Parkinson Cowan Appliances, Ltd., of Stechford, Birmingham. Before his promotion on January 1 he was sales promotion officer to the Gas Division of Parkinson Cowan Appliances, Ltd.

MR. G. G. WARNE has been appointed to the newly-created post of Deputy Distribution Engineer, Southern Gas Board. Mr. Warne was formerly assistant distribution engineer, a position he had held since November, 1956. Prior to this, his career had included 27 years at Portsmouth as Group distribution engineer, and two years as engineer and general manager of the Isle of Wight gas undertaking. Mr. Warne is a past-president of the London and Southern Junior Gas Association and a member of the Council of the Institution of Gas Engineers.

MR. D. C. LORKIN has been appointed Managing Director of Lancashire Dynamo Holdings Ltd., as a result of MR. S. F. STEWARD, C.B.E., resigning as joint managing director of the Company. Mr. Lorkin joined Lancashire Dynamo & Crypto Ltd., a subsidiary Company, in 1932, becoming a director in 1946 and managing director in 1951.

Obituary

MR. ELLIS DAWSON, Sales Representative of Radiation Group Sales, Ltd., for the Eastern Gas Board area, died suddenly on December 31, aged 53. He was with John Wright & Co., Ltd., for 14 years before the formation of Radiation Group Sales Ltd., in 1950.

MR. ARTHUR BROWN, who was Works Manager of the Palatine Works of Radiation Ltd., Warrington Production Centre, and a director of Fletcher, Russell & Co., Ltd., died on Christmas Day. Mr. Brown began his career with the organisation as a junior chemist with the Richmond Gas Stove Co., Ltd., in 1913.

Diary

January 15. — INSTITUTE OF FUEL (MERSEYSIDE SUB-SECTION): 9, The Temple, Dale Street, Liverpool. 'Experiences with Industrial Back Pressure Generation,' by J. W. Alexander. 7 p.m.

January 15.—INSTITUTE OF FUEL (MIDLAND SECTION: Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham 2. 'Fuel Efficiency and Measuring Techniques in a Steel Works,' by R. Mayorcas. 6.30 p.m.

January 16. — SCOTTISH WESTERN JUNIORS: 9, George Square, Glasgow. 'The Use of Figures in Administration,' by A. McFadyen, Divisional Controller of Sales, Glasgow and Western Division. 7 p.m.

January 17. — YORKSHIRE JUNIORS: Bradford. 'Water Treatment,' by C. W. Drane, of Albright & Wilson, Ltd.

January 19.—WEST MIDLANDS G.C.C.: Edmund Street, Birmingham 3. Council Meeting at 2.30 p.m.

January 20.—LONDON AND SOUTHERN SECTION, I.G.E.: Pepys House, 14, Rochester Row, Westminster, S.W.1. 'Gas and the Fuel Market,' by Wilfrid Bailey, Secretary to the Gas Council. 2.40 p.m.

January 20.—INSTITUTE OF FUEL (SCOTTISH SECTION): Royal College of Science and Technology, Glasgow. 'A National Fuel Policy,' by G. Nabarro, M.P. 7 p.m.

January 20.—MIDLAND JUNIORS: Staff Mess Room, Birmingham. 'Industrial Gas in Birmingham,' by J. Ellis, Chief Industrial Gas Representative, Birmingham Division, West Midlands Gas Board. 6.30 p.m.

January 26.—EASTERN G.C.C.: Connaught Rooms, Great Queen Street, Kingsway, W.C.2. Council Meeting at 2 p.m.

Dr. Quelch, of Blackfriars fame, watches Billy Bunter try his hand at tossing a pancake on the gas stand at the recent Schoolboys' Own Exhibition at Earls Court. The stand was jointly presented by the Eastern, South Eastern and North Thames Gas Boards.

Hydrorefining benzoles: Paper describes 'striking results'

LARGE-SCALE PILOT PLANT AT THORNCLIFFE

THE manufacture of pure products from crude benzoles which have been hydrorefined was described in a paper presented to a Sheffield meeting of the Midland Section of the Coke Oven Managers' Association.

Authors of the paper, Mr. R. Middleton and Mr. D. Bradley, are both with Newton Chambers & Co., Ltd., as Engineering Division Sales Manager and Chemical Engineer in the Engineering Division Development Department respectively.

Encouraging results on a laboratory scale were obtained by the Coal Tar Research Association's original investigation of catalysts and reaction conditions in hydrorefining. This was followed by the erection of a large-scale pilot plant at the Thorncliffe works of Newton Chambers, and now a considerable amount of experience and 'know how' has been accumulated in regard to the application of the hydrorefining technique to British benzoles.

Striking results of a fairly long-term investigation were set out in the paper by Mr. Middleton and Mr. Bradley.

The problems had been tackled, it was stated, not only with a view to meeting the present specifications for purer benzoles but also to meet the more stringent specifications likely to concern the benzole refiner in the immediate future.

The authors went on to describe the pilot plant at Thorncliffe and the various simple distillation techniques applied to the hydrorefined products. Benzoles were classified into three categories. The first of these included the low gravity benzole from which high-grade benzene could not be prepared by distillation. The second included the benzoles with a small quantity of paraffin in the crude state and the third group was described as paraffin-free crude benzoles.

It was shown that the production of pure products of high quality from classes 2 and 3 by distillation was not only economical but much more remunerative than by acid washing processes.

A freezing technique for the production of super quality benzene was described. This not only decreased further the cost of pure product manufacture from classes 2 and 3 but encompassed class 1 benzoles from which benzene had not previously been extracted.

Processes had been evolved in the treatment of hydrorefined material which gave benzene in substantially complete yields.

As a result, the authors had reached the firm conclusion that the application of these techniques to any benzole was so attractive financially and technically that hydrorefining must be the process of the future of the benzole refining industry.

The immediate installation of hydrorefining equipment to produce materials to satisfy present specifications would place refiners in an advantageous position to meet what must surely come—a market which could only be satisfied by higher grades of benzene.

A hydrorefining plant was essentially a continuous automatically controlled plant, i.e., a 'push-button plant,' it was stated.

Such an installation could be so operated as to produce a hydrorefined material from which benzene of any grade of purity could be produced without any subsequent plant modifications. Only the conditions of operation needed to be changed by figuratively pressing the appropriate button.

The removal of undesirable compounds from complex organic liquid mixtures by catalytic hydrogenation has been practised for some considerable time by the petroleum industry. Benzole refiners on the Continent and the U.S. are abandoning conventional acid washing processes in favour of this new technique.

Gas in lamp-making—Midland Juniors tour

THE Midland Junior Gas Association, with their President, Mr. G. W. F. Cockayne, visited the A.E.I. lamp works at Leicester recently to see the automatic manufacture of mercury and sodium discharge lamps for public lighting, and of lamps for cars, radio, decoration and flash lights.

The works, which employs 1,400 persons, uses a considerable quantity of gas in its processes.

Firms licensed to build new processes plant

THE research organisation established by the Gas Council particularly at the London and the Midlands Research Stations, has been described from time to time in the annual report. Much of this research work has now reached a stage where it is ripe for commercial development.

The Gas Council announces that it has now entered into agreements under which the following companies are licensed to build commercial plants at home and abroad, covering a number of developments relating to the production of gas from coal and oil, which are characterised by operation under a pressure of several atmospheres: The Woodall-Duckham Construction Co., Ltd., Humphreys & Glasgow, Ltd., and Henry Balfour & Co., Ltd.

IDEAS WIN £1,050

DURING the past 12 months over 350 suggestions have been put forward under the North Thames Gas Board's suggestion scheme, and £1,050 has been awarded to the originators of 137 ideas, considered to be original, practicable and useful.

The suggestions scheme was originated by the former Gas Light & Coke Company, and carried on by the North Thames Gas Board. Since nationalisation over 2,000 ideas have been put forward, and of these, 913 have been deemed worthy of cash awards. A minimum of five guineas is given.

The Lord Mayor of Birmingham, Alderman D. Johnstone, and the Lady Mayoress, with (left) Mr. W. K. Hutchison, Chairman of the South Eastern Gas Board, inspect the Easton Amos Engine which the Board have presented to the Birmingham Museum of Science and Industry. The occasion was the official opening by Mr. Hutchison of the extension to the Engineering Hall, on December 17. On the Lord Mayor's left are Mr. N. W. Bertenshaw, Keeper of the City Museum and Art Gallery, and Mr. T. W. Gibson, the Board's Distributing Engineer.

: TRANSATLANTIC CABLE :: TRANSATLANTIC CABLE :: TRANSATLANTIC CABLE :

Students search 2,300,000 premises for 'needles' in Operation Haystack

From Hilding H. Carlson

NEW YORK, December 5.

'OPERATION Haystack' must be recorded as one of the shining examples of the American gas industry's ability to recognise a situation, face its necessities and get on with the job that must be done. Immediately linked with mention of 'Haystack' must be the names of two undertakings, Southern California Gas Company and Southern Counties Gas Company, both of Los Angeles.

Late last spring it was learned that some customers were having difficulties with a certain type of flexible appliance connector. While it seemed probable that only a small number of defective connectors had been installed, the higher viewpoint in the undertakings held that it was 'advisable to locate promptly and replace' those that were in use. The magnitude of the search for these 'needles' is suggested by the total of 2,300,000 premises to be inspected. The 'Haystack' operation was completed in three months.

A task force of more than 700 high school and college students and teachers was recruited for the house-to-house inspection. Before the force was sent out into the field, a training course was presented with information about the unsatisfactory connectors and the techniques of customer relations.

'The efficient teamwork exhibited by all involved in searching out and replacing these connectors during 'Operation Haystack' is a gratifying exhibition of the ability and desire of our people to take on a difficult job and do it well,' Mr. F. Marion Banks, President of Southern California Gas Company, wrote in a letter to employees.

'The results of the survey are favourable in every respect,' commented Mr. Guy W. Wadsworth, Jr., President of Southern Counties Gas Company in a similar letter. 'The work has been completed as economically as was reasonable to expect. At the same time, our customers have been given good reason to feel that the gas company is a responsible firm that takes a genuine interest in its customers' safety.'

Thermal eye

EACH year the American Gas Association selects a person who has made 'the most outstanding contribution to the general interest of the gas industry,' as the recipient of the Distinguished Service Award. This year, Mr. Victor Weber, Vice President of Robertshaw-Fulton Controls Company, was honoured for his conception of the 'Thermal Eye' feature on gas cookers. The device, sometimes referred to as the 'burner with a brain,' maintains a pre-selected temperature in a utensil through a thermostatic contact with the bottom of the utensil.

Leadership

THE Industrial and Commercial Achievement Award, established last year and sponsored by Moore Publishing Company (*Gas Age*), was won by Mr. Everett V. K. Schutt, industrial gas engineer of the Central Hudson Gas and Electric Corporation, Newburgh, New York. The award, a certificate and £178, recognised Mr. Schutt's contributions to the application of gas in textile processing. Also, through his leadership, an annual textile symposium has been established as a joint effort of the American Gas Association and the South Eastern Gas Association. Mr. Schutt presided at the 1957 and 1958 symposiums.

3-D billboards

ADD to your list of uses-for-gas-in-America: Gas-fired boilers generate steam that adds life to spectacular billboards in the Kansas City area. Five billboards feature a colourful three-dimensional cowboy, 25-ft. high, smoking a cigarette and holding a branding iron. Steam comes forth from the cowboy's mouth, the cigarette and the branding iron. Operation cycles at two seconds on, four seconds off. Oh yes, sound is included. A loud hissing accompanies the steam action. Land around one sign has been planted with grass and 100 rose bushes. An operating water fountain has also been installed.

'Hottest brand going,' the billboard asserts. What's the product? Petrol. What's the brand? Conoco. That is Continental Oil Company. Continental . . . *Con*stock . . . the 'Methane Pioneer' . . . liquefied natural gas . . . Canvey Island. Ladies and gentlemen, please hold on to your hats! It could (might) be you—and Kansas City!

Mr. Victor Weber, who won the A.G.A.'s Distinguished Service Award. (See 'Thermal eye')

Accidents

ACCIDENT experience data submitted by 87 undertakings and pipeline companies to the American Gas Association indicates that the frequency rate during the second-quarter of 1958 increased 8.7% over the first-quarter. The severity rate jumped 114%. However, the cumulative record for the first half of the year shows a 5.4% improvement over the frequency rate for the same period of 1957. The severity rate was indicated by 508 days charged per million man-hours, January-through-June, compared with 447 days a year ago. The 87 sample companies represent 38% of the industry's total employees.

Lowest rate

NATIONAL honours for outstanding traffic safety records were earned by 14 gas undertakings and three pipe-line transmission companies in the motor vehicles fleets contest sponsored by the American Gas Association and conducted by the National Safety Council. The 128 gas industry fleets that participated in the contest accumulated a 12-months' total of 346,305,000 vehicle miles. Those fleets had a total of 5,154 accidents for a rate of 1.49 per 100,000 vehicle miles. That was the lowest rate for the four years during which A.G.A. has sponsored the contest.

Gas parade

THE 'Parade of Gas Progress' was the name given to the first appliance and equipment exhibition to be presented at the annual convention of the American

Gas Association since 1952, and 60 companies participated in it. The exhibitors were limited to those who could show 'significant new developments which have become commercially available since October, 1956, soon will be marketed, or are under development.' More than 5,000 convention delegates and guests of the convention visited the parade, spread over 40,000 sq. ft. of Convention Hall, Atlantic City, New Jersey.

New officers

THE American Gas Association's new officers, elected at the recent annual convention, include Second Vice President Mr. Lester T. Potter, also President of Lone Star Gas Company, Dallas, Texas; First Vice President, Mr. Wister H. Ligon, President of Nashville Gas Company, Tennessee; and President, Mr. J. Theodore Wolfe, who is also president of Baltimore Gas and Electric Company, Maryland.

Retail prices

THE latest available indexes of retail prices for fuels and electricity, compiled by U.S. Bureau of Labour Statistics, based on the averages for 1947-1949 as '100.0,' show these September levels:

Gas, all types	128.1
Space heating	130.9
Other than space heating	126.3
10 therms	118.2
25 therms	131.9
Natural gas	129.5
10 therms	113.4
25 therms	133.9
Electricity, composite ...	108.7
100 kW	106.3
Bituminous coal, all sizes ...	132.4
Pennsylvania anthracite, all sizes	141.5
Fuel oil No. 2	129.9

More-and-more

CALIFORNIA'S demand for more-and-more gas continues. An application by the Southern California and Southern Counties Gas Companies to the California Public Utilities Commission proposes a new artery with an ultimate capacity of more than 800 mill. cu.ft. per day. The line would be 200 miles long and 34 in. in diameter. This would be the fourth pipe-line built by the associated undertakings to bring out-of-state gas into the Los Angeles area. The combined daily capacity of the lines would be 2,000 mill. cu.ft.

Picture of Convention Hall, Atlantic City, New Jersey, while the 'Parade of Gas Progress' was under way.

Continuing recovery

'THE [general business conditions] upturn passed the six-month mark during October and business reports have evidenced continuing recovery, even though at a slackened pace,' First National City Bank of New York states in its *Monthly Letter*. 'The general expectation is that new peaks in income and gross national product will be reached in the fourth quarter. Retailers are talking confidently of a record Christmas season. The high level of contract awards indicates sustained residential and non-residential construction activity, and increased automobile production and sales seem assured. An added sign of business improvement is the definite upturn in corporate profits during the third quarter. Industrial purchasing remains cautious; new orders received by manufacturers have been rising, but closely in line with shipments, and backlogs of unfilled orders have levelled off following the steep decline through early spring.'

New A.G.A. officers, see story on this page, left to right, Mr. Lester T. Potter, Mr. Wister H. Ligon, and Mr. J. Theodore Wolfe.

Lighting tariff

'FOR gas lighting only,' is the most unusual designation attached to a proposed tariff filed by the Los Angeles undertakings for authorisation by the Public Utilities Commission last month. The new schedule provides for street lighting and, separately, for residential and commercial installation. The companies point out that this is their first filing of gas lighting tariffs since 1919.

Equal payments

THE equal-payment-plan offered by Brooklyn Union Gas Company, New York, to house-heating customers has been adopted by 49.5% of those customers. As the name of the plan suggests, the customers pay stated amounts each month during the heating season and adjust differences, revealed by meter readings, at the end of the season. Brooklyn Union has 87,324 heating customers.

All-time high

SECURITIES of American gas companies, in 'common stocks,' went to the fifth consecutive month of new all-time high prices in October, when the level was 31.0% higher than in October, 1957. Current dividends were up 6.3% and return a yield of 4.25% to shareholders.

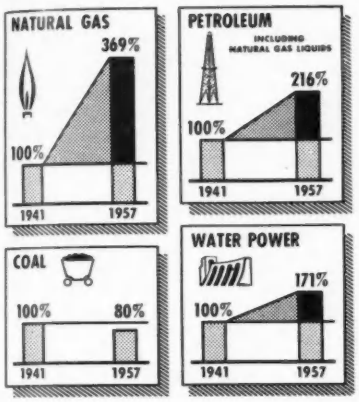
High-B.t.u. gas

DESPITE the emphasis on natural gas supplies in America, a continuing research programme is aimed at developing other sources and means for supplies. Institute of Gas Technology, the educational and research facility of the gas

industry reports an advance in the technology of high-B.t.u. gas production by hydrogasification of coal and oil.

Consumption

ENERGY consumption in the U.S. has just been analysed graphically by American Gas Association to show the percentage changes since 1941 for the principal sources. Increases were calculated for natural gas, 369%; petroleum,



216%; water power, 171%. Coal consumption decreased 20%. A.G.A. emphasised that 25% of the energy consumed here last year came from natural gas. Even though gas consumption was 3.5 times as much as in 1941, the proved reserves of gas available for production are at an all-time high.

Canada

BORDEN COMMISSION CALLS FOR NATIONAL ENERGY BOARD

THE most compelling gas industry news from Canada these days relates to the report of the royal commission that has been studying the needs for controls of gas operations. The report of the Borden Commission, as it is more generally called, does not call for a strict ban against exporting gas to the United States. It skirts that issue by recommending the creation of a National Energy Board that would rule on all export proposals, and it 'suggests' that export licences be limited to 25 years. The entire target of the commission, through the recommended energy board, includes inter-provincial movement of energy, so it can hardly be said that restrictions on exports to the U.S. are the sole objective. In magnitude, however, the market for the large and still-growing proved Canadian reserves will have to consider a heavy flow of gas into the U.S. if the best interests of the Canadian economy are to be served.

That is not to say that less-than-adequate protection should be provided to assure Canadian gas for Canadian markets. Even with that character of protection, a heavy export to the U.S. can be contemplated with consequent dollar-benefits to Canada.

In addition to the 'grant-revoke-suspend' licensing powers recommended for the proposed National Energy Board by the Borden Commission, the constituted Canadian Board of Transport Commissioners would have the recommended power to regulate prices, tolls and tariffs of the pipe-line companies. Also, the Borden Commission would have the Transport Board required to make complete reviews of those prices, tolls and tariffs at least every two years.

A disturbing recommendation in the Borden report was that the incumbent Canadian Government disregard a promise by the former Liberal Government that a licence would be granted to Trans-Canada Pipe Lines, Ltd., for the daily export of 200 mill. cu.ft. to the U.S. Midwestern Gas Transmission Company was to receive the gas for distribution in the upper mid-Western states. One immediate effect has been the refusal of the U.S. Federal Power Commission to grant a certificate to Midwestern Gas because there was no showing that Trans-Canada Pipe Lines would be able to meet its commitments to Midwestern.

Never caught

IF nothing else, American pipeline companies are never caught without alternate schemes. Midwestern and its parent company, Tennessee Gas Transmission Company, refiled with FPC immediately for a new deal which, actually, is based on a Canadian gas supply but is 'geared' so that it will be able to go into action with U.S. gas to be delivered by Tennessee! Canadian gas, said FPC in its denial to Midwestern, 'inevitably will be made available,' for the area that Midwestern seeks to serve. Noting the 'mutual benefits' to both countries, FPC also said, 'When more satisfactory commitments are made . . . we will find it possible to authorise its importation.'

The Borden Commission's recommendations to Prime Minister Diefenbaker will not necessarily be adopted as presented. Even with his heavy majority in Parliament, he might well be expected to give serious thought to the line of reasoning that U.S. investment in Trans-Canada was based in large part on the previous government's commitment to permit export. If, through Parliament, that commitment is 'disregarded' next year, there will be repercussions in the confidence of U.S. investors who might be interested in Canadian enterprise.

Traditional

A NOVEL suggestion is included in the Borden report. It would have a member of the proposed National Energy Board sit with FPC, without vote, whenever FPC considers gas movements across the border. Similarly, it suggests that an FPC member join the Energy Board during considerations of Canadian gas export. That certainly appears to have merit and is in line with the traditional spirit of neighbourliness between our countries.

Stalled

CANADA'S oil and gas industries are 'almost completely stalled in their forward planning,' said the *Financial Post* (Toronto) in a page-one editorial that blames the Borden report. 'There is material in the . . . report which has deeply alarmed the most responsible men in the industries concerned.'

One disturbing note was the vague proposal that pipe-lines be allowed such tariffs as will ensure 'a fair rate of return on shareholders' equity.' The *Financial Post* wonders what rate the Borden Commission had in mind. 'And what figure will sound acceptable to the politicians who will eventualy deal with legislation?'

Gas reserves

HOW much natural gas is in the Canadian reserve? It might have been expected that the Borden Commission would have obtained its own reliable, authoritative and impartial estimate of the total reserve for the Dominion, first as currently proved and secondly as an estimate of ultimate recoverable gas. The Commission was content to use the estimates of Canadian Petroleum Association, British-American Oil Company, Westcoast Transmission Company and Shell Oil Company. That group, curiously, agrees(!) on ultimate Canadian reserves in the magnitude of 300,000,000 mill. cu.ft. If American experience is any criterion, that public statement of reserve is heavily on the 'conservative side.' (For ready comparison, the latest industry estimate of total proved reserves in the U.S. is 246,000,000 mill. cu.ft.)

Public relations

CHEERS! Quebec Natural Gas Corporation was given top honours in public relations achievement by American Gas Association. The Montreal undertaking won the annual A.G.A. competition over 30 other undertakings that came before the Jury of Awards for consideration.

The citation to Quebec Natural, released during the A.G.A. convention, noted that the company as presently constituted went 'into business' just over a year ago. Prior to that, the gas service in the Montreal area was part of a Government-operated undertaking—gas and electric. Further, it was noted that its accomplishments in the public interest involved problems that had never been faced by a gas undertaking in either Canada or the U.S. Colonel Maurice Forget, President of Quebec Natural, responded to the presentation by recognising that it is 'the 1,300 men and women employees of our company whose loyal and able work makes public service possible and . . . our 250,000 customers without whose understanding of our problems and use of our service no achievement would be possible.'

From the Presidential Address to the Wales and Mon. Section, I.G.E., Cardiff, October 29, 1958.

Developments at the Grangetown Works of the Wales Gas Board

By J. B. CURRIER, B.Sc.(Eng.), A.M.I.Mech.E., Assoc.M.Inst.Gas E.,
DEPUTY GENERAL MANAGER, CARDIFF UNDERTAKING.

THE Grangetown works first made gas in 1863. At present it occupies an area of 34 acres. The reconstruction now in hand began in 1954. Since the start of the second world war in 1939, there had been little alteration or extension work, apart from the installation of a third c.w.g. plant and the completion of a fifth set of box purifiers. In 1947 a bulk supply of 6 mill. cu.ft. per day of crude coke oven gas was taken into the works, and the 3½ mill. cu.ft. per day horizontal retort house was shut down. In 1954 it was clear that the rapidly growing demands on the works meant that extra purification plant, and gas compressing capacity would have to be installed quickly, and other alterations would have to be made. The inclusion in the programme of certain new or unusual plant has added to the interest of the reconstruction work. In particular is the Gastechnik installation, which is the first full scale plant erected in Great Britain; the Humphreys & Glasgow liquid purification plant; the butane/propane peak load installation; and the 1½ mill. cu.ft. per hour jet booster.

The annual output from the works has increased from 2,458 mill. cu.ft. in 1944-45 to 4,423 mill. cu.ft. in 1953-54. Similarly the maximum daily output has risen from 8.7 mill. cu.ft. in 1944-45 to 16.9 mill. cu.ft. in 1953-54. In 1954 the production plant consisted of:

(a) a 40-bed 3½-mill. cu.ft. per day horizontal retort house;

(b) a 15-bed nominal 4-mill. cu.ft. per day continuous vertical retort house;

(c) two c.w.g. plants with a maximum total output of 3 mill. cu.ft. per day;

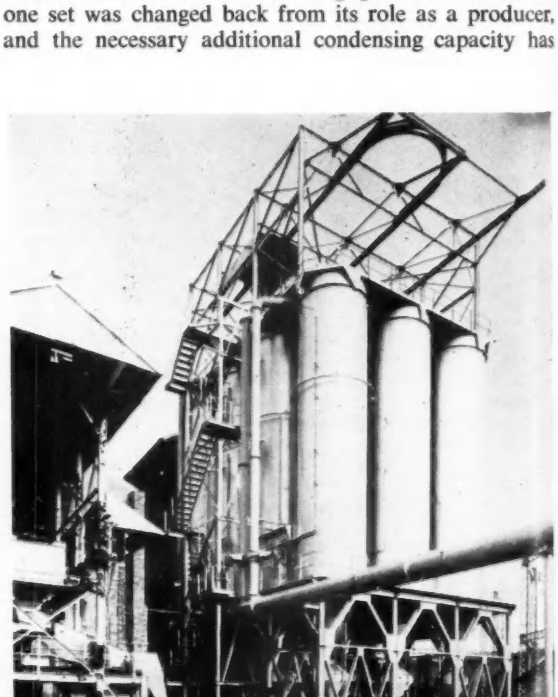
(d) a third c.w.g. plant modified for continuous producer gas production at an average rate of ½ mill. cu.ft. per day.

In addition, a steady bulk supply of 8.7 mill. cu.ft. per day of crude coke oven gas was being received.

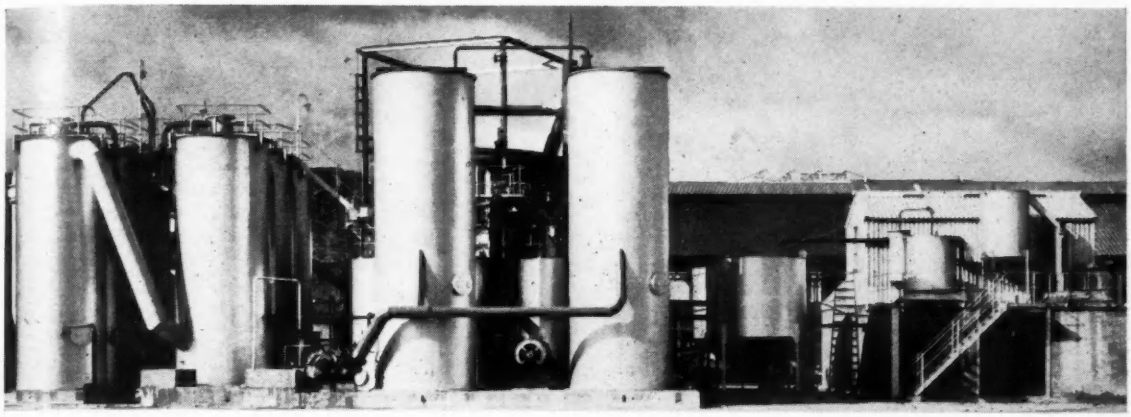
No Further Use

Of the above, the horizontal retort house, built in 1906 was semi-derelict, and its further use was out of the question. In the continuous vertical retort house, built in 1914, only five of the 15 beds, each of eight 33 in. retorts, were in a condition to make gas. Major repairs, to make the other ten beds available, were out of the question because, with the base load coke oven gas supply, it would only be possible for the continuous vertical retort house to work for 4 or 5 winter months each year. Apart from the effect on the plant of such a method of operation, the effect of the lighting up and letting down periods would be to make expensive gas, quite apart from manpower difficulties. Thus, in 1953-54 the total gas availability was just under 16 mill. cu.ft. per day, including approximately 2 mill. cu.ft. per day which at that time could be made available from the grid. An improvement in the gas availability was therefore needed and this was first sought by an approach to the Guest Keen Iron & Steel Co., Ltd., and after negotiation it was agreed that the quantity of coke oven gas supplied would be increased from 8.7 mill. to 9.2 mill. cu.ft. per day on January 1, 1955, and that a further increase to 12 mill. cu.ft. per day would take place on January 1, 1956.

In order to make all three c.w.g. plants available, the one set was changed back from its role as a producer, and the necessary additional condensing capacity has



The 12 mill. cu.ft. a day Gastechnik purification plant.



The 6 mill. cu. ft. a day Humphreys & Glasgow liquid purification plant.

been installed to permit all sets to work at the same time. Further, a 6 mill. cu.ft. per day Connersville meter has been installed so that the c.w.g. is now separately metered. In addition to this, it was decided in 1956, to install a butane/propane plant, and this (described later) stores the equivalent of 10 mill. cu.ft. of gas of a c.v. of 475 B.t.u. per cu.ft. The maximum rate at which this plant can at present be used under peak winter conditions without upsetting combustion characteristics on the district, is to yield 3 mill. cu.ft. per day of gas of a c.v. of 475 B.t.u. per cu.ft. Both the horizontal and the continuous vertical retort houses will be demolished and additional gas making plant is at present under discussion. The present availability of gas at 475 B.t.u. per cu.ft. is approximately 21 mill. cu.ft. per day. The maximum day to date was 19.4 mill. cu.ft. in January, 1958.

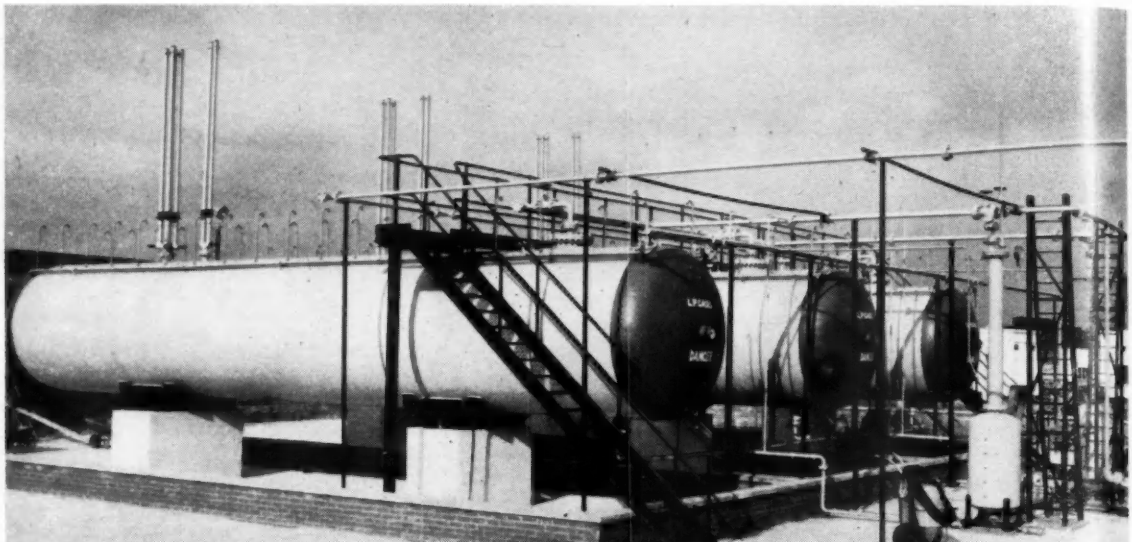
Common Main

The liquefied petroleum gas plant was installed by W. C. Holmes & Co., Ltd., much of the specification detail having been prepared by the Gas Engineer's department. It consists of three cylindrical storage vessels, each of which can gravity feed liquid fuel to either of two identical steam heated vaporisers. The vapour from these goes to Peebles governors which feed it into a common main carrying the mixed gas stream from the production/purification area to the gas holder area. Boiler flue gases taken through a simple wash box and an exhauster, are used for dilution purposes. At the holder end of the common mixed gas stream is a Sigma Kent c.v. control unit, normally set to the declared calorific value of 475 B.t.u. per cu.ft. As soon as the c.v. of the gas which this instrument is monitoring drops below the declared value, the vapour valve at the outlet of the vapour governors is impulsed by means of a compressed air system and opens and closes according to the air pressure changes caused by the Sigma Kent control unit. The degree of 'swing' this control permits is found to be less than ± 5 B.t.u. per cu.ft. Also under automatic control is the vaporiser steam supply, the steam valve being opened or closed according to the pressure in the vaporiser. Each storage vessel will hold 33⅓ tons of liquid fuel, so that the plant has a total capacity of 100 tons. Either butane or propane, or a mixture thereof, is supplied from the Llandarcy refinery, according to availability. The liquid fuel is delivered by special road tanker in 10 ton loads. The vehicle is weighed in and out of the works, and has its own built in transfer pump and a liquid delivery meter.

An interesting safety system on this storage plant consists of small bore tracer tubes strapped to the liquid gas pipe lines. This system of tracer tubing can be very quickly pressurised by a few quick strokes on a small hand operated hydraulic pump, and on raising the pressure to approximately 200 p.s.i.g. the hydraulically operated master valves at the base of each storage vessel, open. These are fitted immediately above, and in series with, the normal valve on the vessel's liquid outlet. If one of the liquid lines on the plant is fractured, a tracer line should also fail, thus collapsing the pressure in the hydraulic system and closing the three hydraulically operated master valves. The tracer lines also incorporate fusible plugs, so that a fire around the plant should also close those same master valves. Water sprays have been mounted above the storage vessels to cool the plant should it be found necessary to stop vapour blowing off at the safety valves in very hot weather. There are no manpower problems, and the plant can be brought to full production within 20 minutes. The total cost, excluding capital charges, of the butane vapour, diluted to a c.v. of 475 B.t.u. per cu.ft. is at present 12.8d. per therm. This installation will make it unnecessary in the coming winter to keep the c.w.g. plants standing-by under fire for long periods without gasmaking, and should the demand on the works be similar to that of last winter when 134 mill. cu.ft. of c.w.g. were made, there should be a saving of £6,000.

Small Compressor

Although there was in 1954 an isolated feeder main to Barry which had been in operation for five years, the Grangetown works—the largest in the Eastern Grid—had no compressing plant to export any gas into that grid. There was, however, a small compressor at the Bute Terrace station of the undertaking which could pump 100,000 cu.ft. per hour to Newport. It was therefore decided to install two existing secondhand electrically driven compressors, from elsewhere in the South Wales Grid, as the nominal grid compressors, with



The 3 mill. cu.ft. a day (475 B.t.u. per cu.ft.) butane/propane gas plant.

capacities of 65,000 cu.ft. per hour, and 135,000 cu.ft. per hour respectively, at 30 p.s.i.g., these would be in addition to the new Cardiff compressors referred to later. All compressors were to be arranged so that various combinations could be used to meet the undertaking's changing requirements and the grid's needs as they occurred.

Major Saving

The existing compressors at the works were two of 300,000 cu.ft. per hour capacity, each with a maximum gas delivery pressure of 17 p.s.i.g. driven by reciprocating steam prime movers exhausting to atmosphere, which supplied the Whitchurch area of Cardiff, and Barry. To effect a major saving in running costs as quickly as possible, orders were placed for two Belliss & Morcom compressors, each capable of 229,000 cu.ft. per hour, and operating at a pressure of 30 p.s.i.g. Of these, one would be an oil engine driven unit for the base load duty, with dual fuel equipment to ease the surplus gas problem in the summer, and the second would be driven by a 435 h.p. variable speed D.C. motor with Lancashire Dynamo Nevelin Varionic drive. This particular changeover from steam has reduced operational costs at the rate of no less than £33,000 per year. The extra saving with the dual fuel unit by using gas in summer, is approximately an additional £600 per annum.

The 1½ mill. cu.ft. per hour town gas booster at the works was steam turbine driven, exhausting to atmosphere, with no standby. While the conventional way would have been to place an order for a complete new booster and prime mover, the idea was put forward from within the undertaking to save the capital cost for the standby duty by using existing compressors, which could be made available in an emergency, in conjunction with a large simple jet booster to induce low pressure gas to give the appropriate volume of gas to the district governors at the required pressure. If the idea succeeded, the jet booster could be worked as base load while the existing booster was converted from steam turbine to electric drive. This standby district boosting plant, and an electrically driven conventional machine (instead of steam turbine driven) could both be installed for a fraction of the capital cost normally incurred. More important, the reduction in operational costs would be no less than £6,000 per annum. The lower efficiency of the combined compressor/jet system would not be important, because the standby would only be used in the event of a breakdown of the electrically driven booster, or for 'no cost' boosting using gas from the grid at those periods when it becomes embarrassed by high pressures. It is believed that a jet booster of this size is unique, but it has been fabricated and designed by the Board and has now been put to work. Its performance is very satisfactory. It has now been operating as the sole booster on the district each day since October 6. The conversion of the conventional booster to electric motor drive through a scoop controlled fluid coupling is now almost complete.

Steam Ejectors

Numerous pits scattered all over the works were frequently pumped out by steam ejectors. The cost of this was further increased by the long runs of small steam lines. These have now been eliminated, and where necessary replaced by electrically operated pumps. At the same time, various steam prime movers have been replaced by electric drives. Four Lancashire boilers have been removed, and another six will be taken away shortly. The principal rôle for steam in future will be for sulphur recovery, and when more experience of this has been gained the two remaining Lancashire boilers may be retained for emergency use only, and an appropriate boiler installed immediately adjacent to the Gastechnik sulphur recovery plant. A simple home-made alternative gas firing arrangement

has been installed on the two Lancashire boilers still in operation, which enables the changeover from solid fuel to gas or an appropriate blend of the two to be made without any delay. This assists the grid during the summer, and saved the undertaking last year about £3,000.

In 1954 there were six separate electricity supplies into the works, each separately invoiced. An electrical reorganisation was effected after negotiations with the electricity authority, by which the 400 volt supplies were superseded by two independent 6,600 volt lines, brought into the works from opposite directions to form a ring system. The electricity authority agreed to pay for suitable primary windings on the transformers, so that a simple changeover will be possible when in the future the voltage of the incoming supplies is raised to 11,000 volts. The new supplies were taken to a new central switchgear room built adjacent to the compressor/booster houses. Six old rotary washers and two Livesey washers were scrapped to make this possible. Suitable automatic power factor correction equipment has been installed and has cut operating costs by £750 per annum. Each major works' circuit has its earth leakage indication system, which has already proved useful in giving warning of faults, and has made it possible to locate and deal with them before they become serious.

In 1954 a standby electricity supply was provided by two steam and four gas engine driven D.C. generator sets, mainly for the purpose of keeping the vertical retort house at work, all the motors there being D.C. In the original planning of the present reconstruction, it was the intention to purchase a new 400 kW. oil engine driven alternator set as a standby, and also for keeping down maximum demand charges when the dual fuel compressor was shut down for routine overhaul. However, two secondhand 400 kW. oil engine alternator sets both in excellent condition became available. By purchasing both of them, the standby provision was doubled and the capital outlay reduced by £4,000.

Purifier Installations

There were five conventional box purifier installations. Nos. 1 and 2 installations were of the ground level water lute type, No. 3 was of the overhead water lute type, and Nos. 4 and 5 were both overhead installations equipped with dry seals. It will be clear from the figures on gas demand already quoted that these five installations with their combined total nominal capacity of less than 9 mill. cu.ft. per day were already quite inadequate for the steadily increasing load, and that the question of dealing with this matter of purification was extremely urgent. It was noted that in the No. 4 installation, connections were such that only four boxes could be rotated and there were two permanent catch boxes. Alterations to connections were quickly made so that these boxes could be rotated as a six-box installation, one box normally being kept off. For the 1954-55 winter, there was no time to install additional plant, the maximum day then being 18 mill. cu.ft. compared with 16.9 mill. cu.ft. the previous winter. To help to safeguard gas purity an emergency sodium carbonate washing plant, using an old disused large overhead tank, and the hitherto disused benzole scrubber, was hastily improvised. Gas purity was kept within the Gas Referee's standard throughout the winter. It was clear that the Nos. 1, 2 and 3 purifier installations with their water lutes and centre valves, all built in the 19th century, and representing altogether a total of only 3½ mill. cu.ft. per day of purifying capacity, would soon have to be scrapped, and in the selection of new plant, speed of installation had to be an important consideration.

After very careful investigation, it was decided to order a 6 mill. cu.ft. per day Manchester-type liquid purification plant from Humphreys & Glasgow Ltd. This was to be for purely peak load duty with no standby, and therefore operational costs were, within reason, of less importance than capital costs. This plant went to work on October 1, 1955, and although it had to be carefully watched, from the outset it purified gas that was passed direct to district holders, and it has not let us down. The continuous H_2S record on the plant outlet is checked each hour, and there is an independent check where this stream joins the other gas going to the holders at 20 minutes to, and 20 minutes past, each hour. During this last 1957-58 winter this plant worked non-stop from November 5, 1957, to May 21, 1958, and caused no difficulty whatsoever.

Full-scale Plant

The Gastechnik purification plant installed here by Robert Dempster & Sons Ltd., of Elland, was the first full-scale plant to be ordered in Great Britain, and is also the largest to be erected so far. It went to work on July 11, 1957, and has purified the crude coke oven gas supply to the Gas Referee's standard without difficulty. Although originally a nominal 8 mill. cu.ft. per day installation, it has been operated at the rate of 12 mill. cu.ft. per day for long periods, and on occasions has handled double the original nominal load for one or two days. The sulphur recovery plant has been completed. It was put to work recently and the early indications here too appear quite promising.

The works' gas storage comprises five column guided holders with a total capacity of 6.7 mill. cu.ft. This is clearly inadequate in view of the maximum day figures already quoted, although the installation of the butane/propane storage plant has helped materially. New gasholder storage totalling 6 mill. cu.ft. is provided for in this current reconstruction programme.

The six station governors are far from satisfactory, and it is planned next year to replace them with three new governors. This has had to be deferred longer than we would have liked because of the pressure of other work of even greater urgency. The cramped conditions in the governor house cellar and the numerous valves therein which are locked solid from decay and lack of maintenance, mean that this work next year will necessarily be a major operation.

Building Section

It was felt that one way to accelerate all the work that had to be undertaken, and to economise, would be to form a building section in the undertaking. This would cut out the use of numerous small contractors, and at the same time make it possible to have work properly supervised and rapidly carried out. Such a section was formed in January, 1956, with an experienced foreman and 15 men. It is now double that size and the range of work has increased. In addition to dealing with the

undertaking's requirements, the section now looks after numerous Board properties, and carries out showroom alterations over a considerable area of South Wales.

There were no facilities for proper maintenance of vehicles. It was decided to provide these, and to carry out virtually all repair work ourselves. A block of adjoining single and double garages was converted by the building section into one large building. New equipment was installed, including an unusual twin post hydraulic lift, and pressure greasing equipment. Another section of the building was provided with numerous small items of repair equipment. A garage foreman and motor mechanics were appointed, and since then the appearance and the performance of the fleet of vehicles has been improved to a proper standard, with a corresponding reduction in operating costs. We have standardised on one make of vehicle, and most new ones purchased are diesel. On the works a lorry and mechanical shovel which used to be on permanent hire have been replaced by our own units, and, in addition, the hiring of horses and carts was also stopped. As soon as the garage section was well established, it also took over the repair and maintenance of the vehicles run by the Grid Manager's department and the Mechanical Engineer's section, and the responsibility for most mobile plant.

The past four years have certainly been intensive for a small staff, and much work on demolishing old plants and erecting new has been in hand continuously. With the coming installation of additional gas-making plant, gas boosting units, gas dehydration plant, etc., the reconstruction programme still has some way to go.

GAS ON THE CONTINENT

Anti-freezing equipment for pressure-reducing stations

By J. Tonnellier, Rheims

THE severe winters of North and Eastern France make it necessary to take special precautions at gas pressure reducing stations to avoid operating difficulties during cold weather. Various means have been employed in the past but the most satisfactory has been to heat the station by an enclosed gas radiator, ignited from outside. To avoid heating the whole building experiments have been carried out in heating the gas itself before it enters the reducing valve.

Two years ago a special electrically operated immersion heater placed in the gas stream was tried successfully and the temperature of the gas entering the station was raised by 10 to 20°C., according to the current applied to the heater and the flow of gas in the main.

The apparatus consists essentially of a section of steel tube 150 mm. diameter by 1 m. long flanged at both ends. The heating element is twin pyrotenax resistance cable of suitable section and conductance so that, even at the lowest rate of gas flow, the gas temperature does not exceed 50°C., which is the limiting safe temperature of the membranes of the reducing valve. The electrical connection to the immersion heater is by a twin cable through a pressure-tight connection brazed into the tube. Under no operating conditions does the temperature of the pyrotenax cable exceed 300°C., as laid down in the relevant regulations. The necessary electrical controls —the switches and the thermostatic regulator—are placed in a box outside the station.

The installations now in use have been designed for district governors for gas flows of 200 to 500 cu. m. (7,000 to 18,000 cu. ft.) per hour, at normal pressure. Voltages of 127 or 220 V with an output of 1 to 3 kW according to the supply can be used in the same apparatus.

For such installations thermostats are not required because experience has shown that even at zero gas flow the temperature never exceeds 50°C. at the governor, since any excess heat is dissipated in the piping. For higher rates of flow and consequently higher voltages a thermostat would be necessary and in one case a thermostat with two heaters in series has been installed.

This method of gas heating can also be used for high capacity, high pressure gas mains—in fact it has been used under a pressure of 60 atmospheres—so that it is applicable to pressure reducing stations feeding public distribution systems from arterial transmission mains. In such cases, a three-phase electrical supply is used with triple pyrotenax cable to preserve the single electrical connection to the heating elements.

Since the heater is placed before the gas filter it was feared that there might be an accumulation of dust in the heating element but no such difficulty has arisen. Where large quantities of dust were to be expected the heater could always be placed before the filter. Though the apparatus has only been used so far with coke oven gas, it could be used in similar conditions with natural gas, but it might be necessary to arrange for a greater increase in gas temperature to compensate for the greater loss of heat with natural gas with its lower proportion of hydrogen.

From the *Journal des Usines à Gaz*, October, 1958

Buyers' Guide to Fuel Oil

THE latest in the series of buyers' guides reprinted from the Purchasing Journal covers the whole picture of fuel oils from their present and probable future position in relation to other sources of energy to details of grades, analyses, and specifications. It is written by A. C. Dunningham.

The chapter on delivery and storage has some useful information on economical ordering quantities and storage facilities, together with a map of price-zones and a pence-per-therm comparison with coal.

Published by Purchasing Officers' Association, Wardrobe Court, 146a, Queen Victoria Street, London, E.C.4, price 3s. 6d.

From a paper to the Wales and Monmouthshire Section of the I.G.E., Cardiff, October 29, 1958.

Jet Boosting and its Application in Wales

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THE technique of jet boosting, although by no means new to the gas industry, has not been very widely adopted in the past. However, the increasing use of high pressures for transmission of gas has led to the development in Wales and elsewhere of jet boosting as a means of utilising residual pressure energy at grid reception stations and other suitable positions.

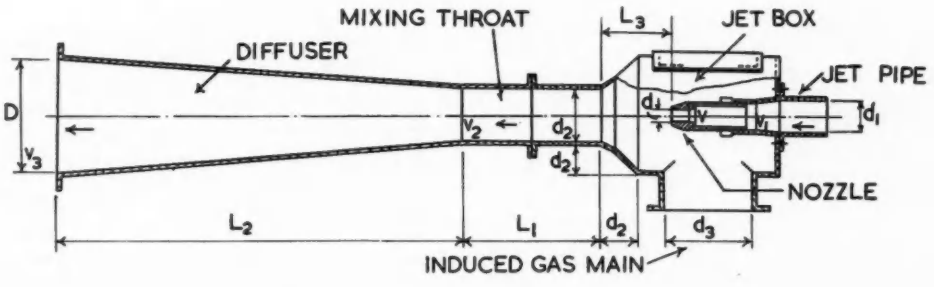
The development of gas grid systems which has taken place in this country, particularly since vesting date, has made or will make available to most undertakings a medium or high pressure bulk gas supply. The pressure energy of the grid gas is usually destroyed in passing through volumetric governors at reception stations. Very often some of this energy is used in transmitting some proportion of the incoming grid gas to a second holder station or medium pressure district main by the installation of an inlet pressure regulator situated on the inlet to the main station holder. The steadily increasing peak loads on district mains has resulted in the need for higher initial pressures from station governors and where holder pressures are inadequate, particularly with uncupped holders, some form of boosting is essential. In many cases, instead of using traditional fan or rotary type boosters, jet boosters may be used which make use of some of the pressure energy of the grid gas. Jet boosting is, however, possible in other circumstances where a high pressure gas supply is available and examples are given later in the paper.

The basis of jet boosting theory may be simply described as follows. Referring to Fig. 1, high pressure gas is allowed to expand through the nozzle, thereby converting its pressure energy into kinetic energy. The emerging jet gas stream flows at a high velocity into the mixing throat of the venturi tube and thereby induces low pressure gas from the jet box which surrounds the nozzle, into the venturi throat. The combined gas stream emerges from the mixing throat and, in flowing through the diverging diffuser, loses velocity, thereby gaining pressure energy The expansion of the jet gas through the nozzle has been considered to take place in accordance with three differing laws, namely:—

(1) *The simple law of incompressible fluids*, where the jet pipe pressure does not exceed, say, 1.5 p.s.i.g. and where compressibility is negligible.

(2) *The isothermal law*, where the temperature of the gas after discharge through the nozzle is assumed to be the same as the temperature before discharge. It is approximately true for jet pipe pressures up to, say, 7 p.s.i.g., where jet box pressures do not exceed a few inches water gauge.

(3) *The adiabatic law*, where it is assumed that there is no transfer of heat to or from the jet gas. It is



LEGEND : Where V = jet gas velocity, ft. per second ; V_1 = gas velocity in jet pipe, ft. per second, V_2 = gas velocity in mixing throat, ft. per second ; d = nozzle diameter ; d_1 = jet pipe diameter ; d_2 = mixing throat diameter ; d_3 = induced gas main diameter.

Fig. 1. Section of jet booster.

approximately true throughout the range of jet pipe pressures which are likely to be met in practice.

In appendix 1 of the paper, the fundamental theory underlying the mechanism of jet boosters is given, from which equations have been derived relating gas jet velocities and flow rates to jet pipe pressure, the nozzle diameter, specific gravity of the gas, the theoretical pressure lift, the ratio of combined gas flow rate divided by jet gas flow rate, and the major dimensions of a jet booster.

From the adiabatic law, an equation,

$$\frac{2}{\gamma+1} = \left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}$$

where γ = the ratio between the specific heat of gas at constant pressure and constant volume.

P_1 = Jet pipe pressure, lb., per sq. ft. absolute,

P_2 = Jet box pressure, lb., per sq. ft. absolute,

shows that the theoretical maximum volume of gas which can pass through a nozzle occurs when the speed of sound at nozzle outlet of jet box pressure has been reached. With a jet box pressure of 8.5 in. w.g. or 15 p.s.i.a., the theoretical maximum jet gas discharge rate is shown to occur at approximately 28.2 p.s.i.a., or 13.5 p.s.i.g. In all cases, however, it has been assumed that, after mixing in the throat of the venturi, the combined gases flow through the diffuser in accordance with the simple law for fluids, ignoring compressibility. A graph included in the paper showed the relationship between jet pipe pressures, theoretical jet gas velocities and flow rates in accordance with the equations derived from expansion in the three laws indicated above. In addition, the curve of theoretical (instantaneous) jet gas temperature immediately after adiabatic expansion was given. These curves show that, whereas, above 7 p.s.i.g. jet pipe pressure, the theoretical velocity of gas which has expanded in accordance with the adiabatic law is less than the theoretical velocity for an isothermal expansion. The converse applies to the flow rate curves (which are adjusted to S.T.P. conditions). The reason for this phenomenon is that the reduced temperature of the emerging jet gas in an adiabatic expansion causes the instantaneous density to be greater than the density of an isothermally expanded gas. This increase in density more than offsets the lower velocity of the adiabatically expanded gas and thus gives an S.T.P. flow rate higher than the isothermal S.T.P. flow rate. Reference to other equations shows that the pressure lift h_L for any given jet pressure, is independent of the specific gravity of the gas, and is only a function of the ratio between the flow rate of the combined or output gas and that of the jet gas, referred to later as R_1. The actual jet gas flow rate, however, is dependent upon the specific gravity.

Design Nomograms

In order to eliminate the need for working through the numerous equations derived in appendix 1 every time a design for a specific jet booster is called for, it was felt that the production of design nomograms would be a most useful contribution to the paper. These were given in appendix 2 of the paper. With their help a jet booster for any output up to 2 mill. cu.ft. per hour can be quickly designed without the use of complicated equations and the consequent risk of error. In designing a jet booster, the engineer should work on the maximum ultimate output required in order to obtain the major dimensions. The only dimensions which need be changed during the working life of the booster would thus be the critical nozzle diameter, d. The nozzle can quite easily be changed when the required output from the booster exceeds its capabilities. It may often prove difficult to design a booster exactly in accordance with the nomograms. For example:

(a) The available length for the booster installation may be severely restricted. In such a case, it will probably be decided that the somewhat lower efficiency caused by a shortened venturi can be accepted, especially if a jet pressure higher than that theoretically required can be made available.

(b) The diameter of connecting mains may be relatively small. In such cases, higher gas velocities in the induced gas mains and outlet mains would have to be accepted.

Maximum Value

Referring next to the ratio R_1, a maximum value of about four may be expected to give useful results. For ratios higher than this, the pressure lift h_L would be insufficient for most purposes. Arising from consideration of the R_1 ratio is the interesting fact that the peak hour flow rate from a typical holder station is approximately three times the average flow rate from the grid into the station. If, then, adequate storage is available, the ratio R_1 at peak periods is usually about three and all the gas passing through the volumetric governor is discharged from the nozzle of the booster straight to the station governor together with twice as much induced gas from the holder.

The nomograms which give the jet pipe nozzle diameter, d, have been based upon an assumed specific gravity of .4. For any other specific gravity, the indicated dimension d should be taken from the nomogram and multiplied by $\left(\frac{S}{.4}\right)^{1/4}$ For example, where S = .5, multiply the indicated dimension d by 1.058 to obtain the actual dimension required.

Empirical curves have been prepared showing the connection between the ratio $L_1:d_2$—the length of mixing throat divided by its diameter—and jet pipe pressure for three different R_1 ratios. Similar curves have been prepared showing the ratio $L_3:d_2$—the distance of the nozzle end from the mixing throat entrance divided by the mixing throat diameter—against the same bases. Both sets of curves were to be found in appendix 2 of the paper. The general trend of the curves shows that for a given jet pipe pressure the lengths $L_1 + L_3$ are reduced as the ratio R_1 is increased. Similarly, for any fixed R_1 ratio, the lengths $L_1 + L_3$ are reduced as jet pipe pressure falls. If, in a particular design, space does not permit the use of the full length L_1 as indicated by the curves, some compensation for the shortened mixing tube may be effected by slightly increasing L_3. The overall efficiency of the booster will, however, be slightly reduced.

The optimum included angle between the jet booster

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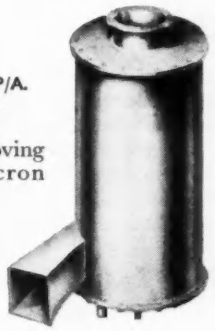

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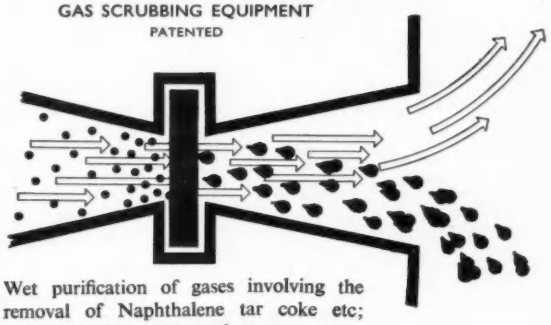

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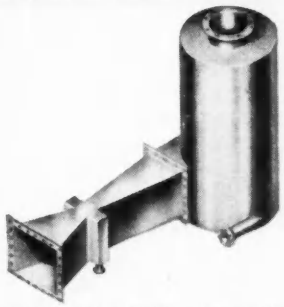

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axis and the diffuser walls should be betwen 5° and 10°. One final point which should be remembered is that the actual pressure lift given by any booster cannot exceed the theoretical value indicated in the nomograms multiplied by $1\text{-}1/R_2^4$ —where R_2 is the ratio between the outlet main diameter and the throat diameter. Thus, as the ratio R_1 increases, the ratio R_2 decreases and consequently a booster with a high R_1 ratio has a relatively low efficiency.

Standard Materials

Basing the design of the overall dimensions of a jet booster upon the equations and/or the nomograms as indicated above it is recommended that the body of the booster be fabricated from standard materials in order to obtain the lowest cost. For example, mild steel tubing to the nearest standard size could be used. It has been found that the extra efficiency gained by radiusing the mixing throat approach pipe and diffuser does not justify the additional cost and trouble involved. All internal roughness, particularly at welded joints on the venturi should be removed. The only critical dimension is the nozzle diameter, d. The nozzle itself is best made from brass or gunmetal with the internal surfaces polished. Longitudinal and angular adjustment relative to the axis should be provided for the positioning of the nozzle. Access by means of a removable cover on the top of the jet box is necessary for inspection or replacement of the nozzle.

Ancillary Equipment

In deciding upon a station layout and types of ancillary equipment which are necessary when a jet booster is to be installed the following points require consideration:—

1. Since the pressure lift of a jet booster is roughly inversely proportional to the square of the ratio R_1, it is obvious that, when district demands for gas are low, the booster outlet pressure will be relatively high, depending upon the jet pressure. It is possible to arrange for an automatically variable jet pressure to give the required booster outlet pressure corresponding to district demand, by the installation of a pilot operated governor in the jet pipe. This method of control is now under consideration for the Cardiff jet booster described later in the paper. The more usual procedure, however, is to instal a station governor on the booster outlet.

2. If the jet pipe pressure is plotted against the pressure difference between the outlet of the booster and the jet box, when the induced gas flow is zero, it can be seen that, should the holder be inadvertently grounded, negative pressure would occur in the jet box which would probably cause the collapse of the holder crown. The magnitude of negative jet box pressure is greater with lowest d_2:d ratios and highest jet pipe pressures. As a general rule, then, anti-suction devices *must* be fitted to all jet boosters. The cheapest and simplest device consists of a by-pass between the jet pipe and the jet box, the diameter of which should be not less than the jet pipe diameter. In this by-pass line should be fitted a low outlet pressure regulator set to open when the jet box pressure falls below, say, 1 in. w.g.

3. A standby electrically-driven booster is normally necessary when a jet booster is installed.

4. The induced gas main performs three functions, *viz.:*

(*a*) It carries induced gas from the gasholder to the booster at peak periods,

(*b*) it carries gas from the booster into the gasholder during off peak periods, and

(*c*) it carries low pressure gas from the holder to the station governor should both the grid pressure and local electricity supply fail at the same time. Consequently, a jet booster requires no separate by-pass and non-return valve to maintain safe district pressures.

5. No special foundations are needed for a jet booster which is a comparatively light unit. It is usually only necessary to provide suitable pipe supports.

6. No excess pressure relief governor is required on the outlet of a jet booster because it is non-positive in operation.

There are three main layouts by which jet boosters may be installed to perform different duties.

(*a*) A jet booster can be installed at a typical grid reception station and this is probably the commonest layout incorporating a jet booster. In such a layout high pressure gas from the grid passes through a volumetric governor and is maintained at a predetermined intermediate pressure by an inlet pressure regulator situated in the holder inlet main. Intermediate pressure gas passes through the nozzle of the jet booster and, either induces holder gas towards the station governor, or flows into the holder via the induced gas main, according to district demands. Some or all of the boosted gas could, of course, be transmitted to a district governor through a suitable feeder main. Running costs for the boosted district supply are thus practically eliminated as the standby electrically-driven booster is only for use in the event of a grid pressure failure. In rural areas where provision has to be made for electricity power cuts, the installation of a jet booster eliminates the need for an expensive diesel-driven machine as a standby to an electrically-driven booster.

High Pressure Holder

(*b*) In certain circumstances a jet booster can be used in conjunction with a high pressure holder to supply, for example, a new suburb on the perimeter of an already extended low-pressure mains system. In such an installation the h.p. holder is filled at off-peak periods by the compressors withdrawing gas from the low-pressure feeder main. When demands of the district rise and the l.p. mains pressures fall to a predetermined value, the compressors cut out and allow the high-pressure gas to flow through the jet booster thereby inducing and boosting the low-presure gas to supply the new district. It is assumed, of course, that the existing l.p. feeder main is capable of supplying the necessary induced gas to the booster at peak periods, namely, about two-thirds of the maximum demand.

(*c*) A jet booster can be installed as a standby to an existing fan booster when a supply of high-pressure gas can be made available. This is the function of the Cardiff jet booster.

It must be stated that power charges for the compressors which in the case of the Cardiff installation have to be diverted from other duties by special arrangement, are much higher than the power charges for the

fan booster. At Cardiff, for example, the power charges for the jet booster are over four times as high as for the fan booster at full rated output. Since, however, the jet booster in such an installation is available for stand-by purposes only, the reduced capital cost generally far outweighs the higher running costs and gives a very real annual saving when compared with the total annual charges for a standby fan booster. The proportion of this annual saving rises as the size of such a booster increases. The annual saving at Cardiff, for example, with an estimated annual running time of 200 hours is approximately £430.

Tests have been carried out on two jet boosters which are at present being used in Wales. The first is situated at the Grangetown works of the Cardiff undertaking. It was designed to give a maximum gross output of 1.5 mill. cu.ft. of gas per hour with a pressure lift of 15 in. w.g. The second is situated at Carmarthen and was designed to give an ultimate maximum gross output of 100,000 cu.ft. per hour with a lift of 4 to 5 in. w.g. The tests were, however, made using a smaller diameter nozzle than will be required for the ultimate output.

Conclusions

The authors draw the following conclusions from their experience in the use of jet boosting equipment.

1. The main advantages of jet boosters compared with fan-type boosters are:

   (*a*) Lower capital costs, and longer permissible amortisation period.

   (*b*) Very low maintenance charges as there are no moving parts.

   (*c*) No power charges when installed in a typical grid reception station.

   (*d*) A comparatively wide output range may be attained.

2. The main limitations of jet boosters are:

   (*a*) The maximum practical value of R_1 is approximately 4. Above this value, the pressure lift obtained is not very high within the range of jet pipe pressures so far used.

   (*b*) The maximum theoretical jet pipe pressure required to give maximum jet gas flow rate when the pressure in the induced gas main is a few inches w.g. is approximately 13.5 p.s.i.g. The authors have not yet been able to verify this theory, although they hope to do so in the near future. It is intended to run a jet booster up to approximately 20 p.s.i.g. in order to obtain a clear picture of any 'flattening off' in the jet gas output curve. It is believed, however, that higher throughputs could be obtained with higher pressures but that some instability in outlet pressures would probably be noticed.

   (*c*) A minimum useful jet pipe pressure may be taken as about 1 p.s.i.g. At this low pressure, very limited ranges of pressure lift and R_1 ratios are possible.

3. The average pressure lift efficiencies of the Cardiff and Carmarthen jet boosters are shown to be between 70% and 80% of the theoretical values. The overall efficiency of a jet booster where $R_1=4$, has been shown to be about 20%. If, however, as in the case of the Cardiff booster, the jet gas has to be specially compressed at a compression efficiency of 65%, the overall efficiency is only 13%. In the light of present knowledge, both the Cardiff and Carmarthen booster efficiencies could have been improved. In particular, the length of throat at Carmarthen could have been reduced and the frictional efficiency thereby considerably increased.

Safely Applied

4. The graphs of the results of tests carried out at Cardiff and Carmarthen confirm that the expansion of jet gas from the nozzles approximated to the curves following the adiabatic law throughout the ranges of pressure applied. In view of this, the nomograms have been based upon this law. However, the theory for incompressible gases could be safely applied up to jet pressure of 1.5 p.s.i.g. and the isothermal theory up to 7 p.s.i.g.

5. The performance test figures show that a rapid recovery in the temperatures of the jet gases after adiabatic expansion takes place in the mixing tube and the actual mixing tube temperatures are higher than the calculated temperature. This fact is accounted for by the reheating which occurs after the above-mentioned loss of kinetic energy of the jet gases in the mixing tube.

6. In the authors' opinion, there is no doubt that the use of jet boosters could and should be more widely adopted in the gas industry and it is hoped that this paper will stimulate interest in jet boosting and help other engineers in their design and installation.

WEST'S RE-ISSUE BOOKLET ON CARBONISING PLANT

WEST'S GAS IMPROVEMENT CO., LTD., of Miles Platting, Manchester, have recently issued a new edition of the booklet, 'West's Carbonising Plant.' Attractively produced and well illustrated, it is divided into two sections. In the first is to be found a general description of the carbonising systems employed in the company's plant and some individual ancillary items to be found in the retort or chamber house, while in the second section a list is given of installations throughout the world.

Sufficient detail is given of the carbonising plant to enable any who are unfamiliar with West's carbonising systems to get a very clear picture of the potentialities of the plant and the arrangement of the coke extractor gear, types of producer, off-take valves, etc., normally installed by the company. Those gas engineers who are in charge of existing West's plant are able to compare any advances which have been made since their own plants were built.

World-wide

The section on installation is most interesting in that it shows how world-wide the company's interests are and also how tremendously varied are the conditions of gas manufacture which have to be met. With the tendency to increase the size of manufacturing units in Great Britain, some of the installations abroad seem surprisingly small. The C.O.L. system of intermittent vertical chambers is dealt with separately in each section.

GAS CHROMATOGRAPHIC ANALYSIS

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DURING the past few years, there have been very rapid developments in chromatographic analysis, many of which are important to the gas industry. Thus, the conventional methods for determining the composition of gaseous mixtures, such as that of Bone and Wheeler, or the soap film technique, can now be replaced by gas chromatography.

In this paper, it is shown that gas chromatographic analysis may be applied to town gas, to refinery gas, to the examination of condensates and to the determination of odorant concentration when it is added to gas before its distribution.

The effect of changing over from existing analytical techniques to gas chromatography is to give a considerable improvement in accuracy coupled with more rapid analysis. A material advance in simplicity of operation is achieved and a more detailed knowledge of component composition obtained.

Gas chromatography was first introduced by James and Martin in 1952; since that time it has undergone remarkable development in every field of organic chemical analysis. The gas industry appreciated the potentialities of the technique for the analysis of gases, of benzoles and tar fractions. Densham and Gough showed how gas chromatography, among other modern techniques, is being used to solve these analytical problems. Work is now in hand, at the London Research Station of the Gas Council, to improve the methods still more for the gas industry's particular needs, both in the research laboratory and for the production chemist.

Far wider fields

The word 'chromatography' was originally applied to the separation of chlorophyll into coloured bands of the individual components after passage in a solvent through a tube packed with an adsorbent. Today, chromatography embraces far wider fields of separation; it is the term applied to the separation into components of any material by percolation through a fixed stationary phase, as colourless bands may now be easily detected.

Gas chromatography is essentially very simple. It depends on selective adsorption and desorption of the individual substances in a mixture either by a granular adsorbent or partition by a liquid which is most conveniently held by an inert porous solid. These materials are packed in a tube through which the mixture to be analysed is passed at an accurately controlled rate. As a result of the two distinct mechanisms, the individual substances leave the column outlet separately and are identified by some suitable physical property.

The apparatus consists of ancillary equipment to measure the flow of carrier gas, a narrow column packed with the stationary phase, a detector and a potentiometric recorder. This carrier gas, which must be inert to all components in this mixture, sweeps the gas or vapour sample on to the chromatographic column where separation of the constituents occurs. A detector, which measures small changes in certain physical properties of the medium, senses the component present in the carrier gas stream; it transmits a signal to the recorder where a permanent record of the separation is obtained as a trace chromatogram, each component appearing as a peak.

Either the peak height, or, more strictly, the peak area of a component, is usually proportional to the concentration of that component. An integrator is often used to calculate these areas, which reduces the total analysis time. Several types of integrator are now available for purchase in this country.

In a given column, at a given temperature and pressure, and with a given flow of carrier gas, a given substance will move at a definite speed. Thus, by calibration with pure substances under strictly controlled experimental conditions, the time taken for any component to pass through a column may be accurately predicted. The characteristic value is known as the 'retention time' of the compound. From theoretical considerations, the retention time of any member of an homologous series may be determined, providing that this value is known for any two compounds of the series under conditions employed.

The two distinct forms of chromatographic column have already been mentioned. The use of the adsorption column is confined almost entirely to inorganic gases and organic gaseous fuels containing no more than four carbon atoms. Examples of the common adsorbents used are silica gel, alumina, charcoal, and the artificial zeolites sometimes known as 'molecular sieves.' Adsorption and desorption of each constituent occurs continuously along the narrow column, the length and temperature of which is adjusted to bring about separation of all constituents in the mixture.

In a partition column, an inert size-graded diatomaceous earth filler is uniformly impregnated with a specially chosen organic liquid to an extent of 5 to 30% by weight. Under these conditions, the granular filler still flows freely. The liquid 'stationary phase' must have a low vapour pressure at the column temperature to prevent its removal from the column by the stream of carrier gas.

The mechanism of separation on this type of column is complex and quite different from the adsorption-desorption process. The organic partitioning liquid should produce a differential solubility of the components to be separated. Should these solubilities be very similar with a non-polar stationary phase (such as liquid paraffin), component separation would occur through differences in vapour pressure, as in normal fractionation. A third physical process, which may be used to advantage, is the loose bond formation that can occur between molecules of the stationary liquid phase and molecules of any component passing through the column. Such a bond would be sufficient to retard sufficiently one of two isomers whose close vapour pressures and solubility characteristics still defeated separation. Thus, the choice of stationary phase for any one operation is of major importance. When dealing with unknown mixtures, it is, therefore, necessary to carry out some initial research to determine the types of organic molecules present.

Efficiency of column

The efficiency of a chromatographic column is very high, being reflected in the type of separations achieved. Although the 'theoretical plate efficiency' of a distillation column cannot be compared strictly with that of a chromatographic column, it is not unusual in the latter for a length of 0.5 mm. to be equivalent to one theoretical plate.

It is desirable that the final stages of separation in the column should result in well defined and compact bands: When these are displaced from the column and detected, they will then appear as symmetrical peaks on the

chromatogram. A symmetrical, or nearly symmetrical, peak on the recorder chart is essential for accurate quantitative measurement with adsorption columns, it is difficult to suppress sharp 'fronts' and 'tails' to the curves, but this feature can, however, be minimised by the use of small sample volumes.

The detector used in gas chromatography senses and measures the amount of the component eluted from the column in the effluent gas. It must be compact, sensitive and fast in response. The necessity for being of small volume is most important; the component to be detected is present in the gas stream only in very minute concentration and, therefore, the possibility of back-diffusion of gas molecules must be eliminated. This would otherwise cause an apparent increase in the width of the chromatographic band, which would leak to peak asymmetry. Thus, the detector volume is small and situated as close to the exit end of the column as possible. The increasing number of detectors available provide for these three essential features to different extents.

The most common types in use are those that utilise thermal conductivity and the hydrogen flame, while the most sensitive are those that incorporate ionising radiations. The sensitivity required for modern gas chromatography can be gauged from the fact that for a ten-component analysis no more than 30 microlitres of sample are placed upon the column. More will be said of certain detectors in the following sections concerned with the actual analytical problems.

Specific analyses are given of town gas, refinery gas, the tetrahydrothiophen added to reformed refinery gas for odorisation and of benzoles condensed out of gas.

The results so far obtained indicate that, for town gas, the method gives an accuracy comparable with that of conventional methods with respect to major components, while the degree of accuracy for minor constituents is considerably improved. In addition, it is possible to obtain analysis showing the detailed composition of various groups of compounds (e.g., unsaturated and saturated hydrocarbons), which is not obtained by conventional methods.

The technique has many other uses and is applied at the London Research Station of the Gas Council to the analysis of a variety of gasworks by-products. Particular attention is being paid to the application of new and very sensitive detectors; for example, it is hoped to determine naphthalene and tetra-hydrothiophen directly in a small gas sample by using the argon ionisation detector, which incorporates a strontium 90 or a radium D source.

DISCUSSION

Mr. **M. P. Mendoza,** Gas Analyst, B.C.U.R.A., Leatherhead, said: While we are rapidly becoming acclimatised to regarding gas chromatography by partition methods as the accepted one for the analysis of mixtures of volatile liquids such as benzoles, and even solutions of odorants, conventional gas analysis—what has always been understood as gas analysis by adsorption chromatography—is still very much of a novelty.

By the choice of suitable column packings, it would appear that the task of separating the fuel gas into discrete binary mixtures of one component and a carrier gas has been very largely accomplished. It would seem, however, that due to imperfections in the detecting system, the accurate determination of the components as they emerge from the column presented perhaps a little more difficulty. It would appear that the authors are not alone in wishing that a more sensitive and stable detecting system than the one which they use had been available.

Had a suitable integrator to measure the area under the curve been available to the authors, perhaps they would have taken advantage of it in the increased accuracy obtained by measuring the area under the curve rather than heat height as a quantitative measure of the amount of component mixed in with the carrier gas.

One of the major problems associated with the use of physical instruments for what might broadly be called chemical analysis is that of calibration. Any analysis made with a physical instrument cannot be more accurate than the initial calibration of the instrument. If it is desired to analyse unknown samples such as fuel gas with an accuracy of ± .1%, the minimum accuracy of calibration should be .05%, and preferably better than this.

The use of the results of mass spectrometer analysis for calibration in this instrument, or for a large part of the calibration, I find rather surprising. I am not a mass spectroscopist but from papers which have been published in the literature, largely emanating from Waldron and Metropolitan Vickers, who manufacture the instrument, it would appear that the necessary accuracy of ±.1% is not obtainable with the mass spectrometer for mixtures of the type shown in [Table 1, p. 12]. Although exact parallels are not quoted, it would appear that for what Waldron calls the normal method of analysis, rather larger areas than this were to be expected.

The average area of four analyses for synthetic mixtures containing 4.3% of hydrogen and 10.7% of methane were .74 and .55%, respectively. Even the averages of several determinations show a considerable bias. Using, however, the double inlet method, these errors could be reduced to about .1%, but since this latter method involves rapid comparison peak by peak of the unknown mixture with a known synthetic mixture of comparable composition, it would appear unlikely to have been used, for if this synthetic mixture of accurately known composition had been available it would surely have been used for calibrating the gas chromatographically in the first place. Also, it would seem that the mass spectrometer is prone to give a high hydrogen value at the expense of the other constituents.

Concerning calibrating and checking, I would have preferred to see a synthetic mixture of known calculated composition prepared from constituents of known purity. This is possible in some work on the Bone and Wheeler apparatus. We had occasion to make up six mixtures and we found that in general the agreement between what we intended to put into the mixture and what we got out was very good, with, perhaps, one exception. Such a method, I would have thought, would be invaluable if an accuracy of .1% was ultimately to be attained.

What is the reproducibility of this method of analysis? Are the results quoted in [Tables 2, 3 and 4] the results of single analysis, or are they the mean of several? If so, how many were there, and what was the spread of the individual results?

Dr. J. H. Towler, Research Chemist, Joint Research Committee of the Gas Council and the University of Leeds, said: Spectroscopy is capable of giving an answer in any detail required, but it has some important disadvantages. It requires a good deal of time to obtain a detailed analysis; rather large samples of gas are needed to give sufficient amounts of concentrates to handle; it is not able to deal with monatomic or homopolar diatomic molecules, and the equipment is very expensive.

Approximate cost

Apparently, chromatography has none of these disadvantages. One of my points was to ask the approximate cost of the chromatographic equipment. It is of the order of £1,000, as against infrared spectroscopy at a cost of £3,500; and the cost of gas chromatographic equipment is likely to be brought down. The capabilities and versatility of chromatography are well brought out in the paper. We think that chromatography will be a very useful complement to our spectrometer and Bone and Wheeler apparatus.

I should like to refer to a point which Mr. Boreham mentioned in his introduction. He seems to think that there is some uncertainty about the adsorption of carbon monoxide. There is no doubt whatever that this reagent does absorb carbon monoxide.

We have some doubts about the accuracy of the method when applied to some of the minor constituents of gases. For example, referring now to [Table 4, p. 16], what accuracy would the authors claim for the .3 and .2% of acetylene in mixtures 1 and 2, or for the zero percentage of propane in mixture 2? We assume, subject to correction, that mixture 1 is an oil-gas, probably Onia-Gegi, and the results for this are comparable with results obtained in our own laboratory for a similar gas.

Mixture 2 is quite different. It appears to be a washed horizontal retort gas diluted with producer gas. I have since been told that it is a peculiar product from Portugal. In this case, assuming it to be a horizontal gas we should expect some .3% of propylene to accompany the 2.2% of ethylene and a figure of about .2% for propane. In fact, no propylene is recorded and propane is reported absent. In addition, the acetylene at .2% is

at least twice as large as we have found in any carbonisation gas without any dilution at all.

Turning now to [p. 21, Fig. 7], we see a peak for iso-propyl benzene or cumene which is comparable in size with the peaks for the xylenes. We have found cumene only in carburetted water gas in very small amount, about 1% of the amount of the total xylenes. I should like to know why the authors introduced cumene into the synthetic mixture rather than, say, trimethyl benzenes, which would be present in greater amount in a gas, and whether, in fact, cumene has been identified positively in actual town gases.

Mr. W. J. Gooderham, North Thames Gas Board, said: Too little use is made of accurate gas analyses. They do tell us what gas we are making, how much is inert, what yields of hydrocarbons we are getting from the coal or oil, what the hydrocarbon enrichment value is and how much water gas is being formed. After a little calculation, accurate analyses will also tell us what are the Wobbe Numbers, the specific gravities, the combustion characteristics and the calorific values, and the latter can be contrasted with those actually found. An inspection of the 'n' in C_nH_m and C_nH_{2n+2} will give an excellent assessment of the cracking conditions, while analyses of waste gases will provide information about producers, generators and appliances, and tell us all about leakage from retorts.

Infallible

Would it not be nice if each sizable gas-making station had a constant volume gas analysis apparatus for special analyses, a soap film apparatus and 24-hourly sampling devices for routine analyses of the daily make, a soap film apparatus to assess the products of combustion, and a gas-liquid chromatographic apparatus. May I suggest, however, that before buying the last-named, the developments envisaged on [p. 13] should be awaited. Armed with this apparatus, and, of course, an intelligent being to operate it and to interpret the results, a gas engineer could not go wrong.

The authors of this paper—and incidentally those of G.C. 51 too—have shown us how relatively simple it is—given the apparatus and the 'know-how'—to analyse the more complicated town gas of the future. I would, however, have preferred to see some figures for individual analyses in [Tables 1, 2 and 4] to have heard how to avoid a bad zero line and to know if freezing techniques had been tried for the removal of tetrahydrothiophen rather than the scrubbing procedure described on [p. 20]. I was a little intrigued to note on [p. 12] that drying agents may remove more constituents than wetted filter paper. Some further details might be interesting on this point.

I was amused (and indeed amazed) to find my soap film technique being used as a means of standardising an even newer procedure, and have noted that, contrawise, chromatography has checked the soap film apparatus, which appears to have given excellent figures for carbon monoxide, despite the alleged absoprtion of carbon monoxide by activated sulphuric acid. Combustion in the soap film apparatus must also have been complete to give the agreement shown for the nitrogen figures in [Table 3].

Mr. H. F. Ferguson, B.C.U.R.A.: I was interested in Mr. Gooderham's comments about the gas engineers in the next room producing weird and wonderful gases. I am largely concerned with that project. One of our major problems in accurate determination performance has been the vexed question of the solubility of carbon monoxide in activated sulphuric acid. A typical slagging gasifier would be producing about 65-70% carbon monoxide with 25-30% hydrogen.

We at B.C.U.R.A. have been using comparative analysis between a Gooderham soap film analyser and the Bone and Wheeler apparatus, and we have observed some considerable discrepancies between the determination of unsaturated components.

Mr. P. D. W. Scott, Benzole Producers: I am rather interested to know whether Mr. Boreham is contemplating making an automatic system for a continuous recording of the composition of coal gas by this chromatography, particularly with respect to the determination of benzene, to give an idea of the scrubbing.

Equipment has, in fact, already been designed. Automatic sampling valves are being manufactured which could place a sample of coal gas on to a column and give a continuous recording every so often of the composition of the benzene of the total gas. I would like to know whether Mr. Boreham contemplates following up this line.

Mr. Boreham: Some of the questions which have been put to me require much more attention than can be given now, and I will reply to those questions in writing and discuss them fully.

Mr. Mendoza still seems to think that as far as town gas is concerned, gas chromatography is indeed a novelty. I have no hesitation in disagreeing with that. We have proved, in effect, that it has gone far beyond the novelty stage. We want to get it on a sound footing whereby various boards can use this apparatus and replace the conventional apparatus which is at present used.

Mr. Mendoza asked a question concerning the areas under the curve and said that it would be much better to use integrators rather than to rely on triangulation. I thoroughly agree. We have had an instrument designed for us at Fulham to use with our other apparatus. It is a good integrator capable of giving results to within .1%. It does, however, rely on the fact that we have a completely steady base-line. We find it not very easy to thermostat the instrument sufficiently at a temperature of 30°C. to get a steady base-line, but this matter is being attended to.

I was sorry to hear that Mr. Mendoza was not in favour of the mass spectrometer as a means of analysis, but I am certainly interested in his statement on the use of synthetically blended gases and I hope that in the near future we may be able to co-operate in getting a still more accurate analysis than we have done so far.

In reply to Dr. Towler, the price I quoted of between £800 and £1,000 is perhaps a little high. A lot of this apparatus can be manufactured in the laboratory for much less than that.

The second of the two mixtures shown in the analysis on p. 16 of the paper was, in fact, a peculiar gas which was imported from Portugal. I have consulted my colleague, Mr. Marhoff, who has done all the actual experimental data on the town gas analysis, and he tells me that he can get an accuracy or a lower limit of acetylene down to .5%; and the same thing applies to normal propane and propylene. I cannot deny that propylene has turned up. It is indeed present. Mr. Marhoff told me that he used 25-cc samples, using the apparatus at maximum sensitivity.

I would like to thank Mr. Gooderham for his invigorating speech.

The modern oil gases which are coming on the market these days require much more accurate analysis than could once be given. I refer, for example, to the fact that the refinery gas which is present at Romford is reformed to give a gas with a calorific value of about 300. It is then made up to the statutory figure by means of refinery gas, containing paraffinic and other material. I definitely hesitate to think what the Bone and Wheeler apparatus would make of such an analysis.

Concerning the freezing technique of tetrahydrothiophen, I do not know whether Mr. Gooderham has had any experience of this unpleasant substance, but I assure him that we are quite unpopular enough as it is when dealing with it in a weak solution. Although we could possibly use it concentrated, I do not think that I should like to do it at Fulham.

Silica gel

Concerning the dangers of drying agents in town gas, we have in mind silica gel, which will absorb certain materials if the gas is passed over them. It will, in fact, act as another gas chromatography column and the resulting gas is a quite different proposition to that which preceded the actual drying agent.

I would like to say to Mr. Ferguson that a gas containing 65-70% carbon monoxide would present no actual difficulties in this particular type of analysis. That is another great advantage. It does not matter how concentrated one gas is as regards the whole. We can always find the means of providing a decent chromatogram for the correct answer.

In answer to Mr. Scott, I have automatic recording very much in mind. We have discussed this point before. As soon as we can obtain this new type of detector and have it working satisfactorily, I hope to be able to get this instrument recording at once.